



The Role of CAD systems in field of Medicine

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Abstract

CAD systems have wide application in various branches of science and have found special implementation in field of health and medicine. In the last three decades, CAD systems has been fast developing field and the idea of using a computer in medicine is not new. First researches dating back to the 1960s. Because of recent advances in both CAD and in medical technology, CAD has found increasing use in medical applications and devices. Nowadays, CAD system has become one of the major research subjects in the field of biomedical engineering, clinical medicine, customized medical implants, tissue engineering, dentistry, artificial joints, and robotic surgery. The aim of this study is to research and to analyze the use of CAD systems in medicine and to present the importance of use.

Key words: CAD system, medical technology, medicine

1. INTRODUCTION

Nowadays, when the global market has become a playground for manufacturers who are competing in the application of innovation, it is unthinkable that the process of design, development and manufacturing of products made without the use of computers and modern software [1-5]. First Computer Aided Design software has been developed in Massachusetts Institute of Technology in 1950. In that time was the phase of computer development and for that reason CAD software was underdeveloped. Industries, who were the main users, such as automotive and aerospace, have invested in the development of CAD systems [9]. In future computers have become the most powerful machines in term of memory size and processor speed and found wide use in various areas. In recent years, CAD technology is an extremely powerful and basic tool for work. Contemporary design can not be imagined without the use of CAD software. Continuous improvements and technological breakthroughs have powered CAD into the central role [6].

CAD systems have wide application in various industries and branches of science such as

architecture, electrical engineering, mechanical engineering, civil engineering etc. As well, CAD systems have found special implementation in field of health and medicine. The medical field is currently using the Information Technology (IT) application especially in communications and imaging of scanned images such as x-ray and Computerized Tomography Scans (CT Scans) [7]. The most commonly used format in field of medicine is the Digital Imaging and Communication in Medicine (DICOM). This standard supports the concept of two-dimensional (2D) and three-dimensional (3D) [8].

1.1 History Review

It not new the idea of enlisting the help of computer in analysis of medical images. In fact, CAD has become one of the major research subjects in medical imaging and diagnostic radiology [12 – 20]. In 1963, Lodwick et al. [10] investigated computerized analysis of medical Images but those early attempts were not successful. At that time, it was generally assumed that computers could replace radiologists in detecting abnormalities, because computers and machines are better at performing certain tasks than are human beings.

They further studied the usefulness of computer evaluation in diagnosing and grading of bone tumors [11]. Years later, first serious and systematic investigation on CAD began in the 1980s with a fundamental change in the concept for utilization of the computer output. In the early 1980s were begun large-scale and systematic research and development of various CAD schemes at the Kurt Rossmann Laboratories for Radiologic Image Research in the Department of Radiology at the University of Chicago [21]. One of the most important years in the history of CAD is the year 1998. It marked the transition of CAD technologies from the research phase to industrial practice with the success of the ImageChecker™ (R2 Technology, Inc., Sunnyvale, CA; later acquired by Hologic, Inc. in 2006) in obtaining a Food and Drug Administration (FDA) approval [22].

Nowadays, CAD systems have wide use in medicine and some of them are in radiology, dentistry, orthopedy etc. In this paper will be given an overview of using CAD system in radiology, breast reconstruction and stomatology.

2. CAD SYSTEM AND RADIOLOGY

2.1 Breast and Lung Cancer

Two the most often examples of CAD in clinical areas are the use of computerized systems in mammography and chest CT radiography. World wide a major killer of woman is breast cancer. In United States, approximately 41,000 women die from breast cancer and 213,000 women are diagnosed with breast cancer each year [25]. Nowadays, more than 5000 mammography CAD systems are in current use in hospital, clinics and screening centers in the U.S [26]. Mammography is widely used in breast cancer screening. It is very effective in detecting breast cancer in women over 50 years, but it is not that effective for younger woman or woman with dense breast tissues.



Figure 1. An overall system for breast cancer screening using ultrasound images. The system consists of an ultrasound imaging device and a whole-breast scanning device for whole breast volumetric data acquisition. A workstation is also included for the purpose of pre-processing and analysis of the images acquired by the scanning device from the patient and as a viewer for the visualization of the images along with the CAD results [28].

Although is effective as a screening tool, mammography has limitations. On a screening mammogram, cancers can be missed (false-negative

mammogram), and non-cancerous lesions can be mistaken as cancer, leading to a false-positive mammogram. Depending on how the true cancer status of a woman is determined, the miss rate in mammography can be nearly 50% [26] but the early detection of breast cancer is the key to simpler treatment and a better prognosis. The reason why the cancer is not being visible is the normal tissue which is above and below the cancer and make a camouflages. This is because mammogram is a 2D image of the 3D breast, so the superposition of tissue can hide cancers [25].

Digital mammography has enabled the development of CAD algorithms that enable the use of computers in order to support the radiologist's opinion or for the purpose of making a comparative diagnosis when it is not possible to consult another radiologist. The CAD system consists of several basic modules, such as pre-processing, segmentation and classification. [27] Figure 2 shows interaction between CAD systems and radiological diagnoses [27].

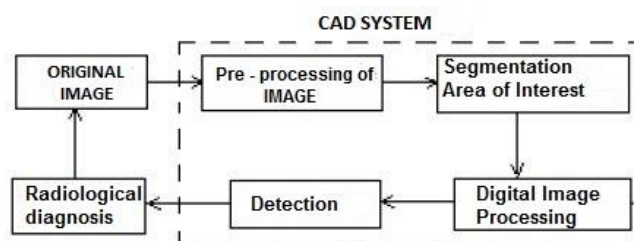


Figure 2. Block diagram that represents the interaction between CAD System and radiological diagnostics.

Alongside of breast cancer in women, lung cancer is the second most common cancer in both men and women. According to American Cancer Society in The United States in 2017 there are about 222,500 new cases of lung cancer . Lung cancer is by far the leading cause cancer death among both men and women. Each year more people die of lung cancer than of colon, breast cancer and etc.

The biggest problem encountered by radiologists during the examination of lung is visual detection of lung nodules. Radiologists have missed these lesions due to the overlap of normal anatomic structures with nodules, i.e., the normal background in chest images tends to camouflage nodules in 2D imagine [28 – 32]. The normal background structures in chest images would become a large obstacle in the detection of nodules, even by computer.

As already mentioned in this paper, the most commonly used format in field of medicine is the Digital Imaging and Communication in Medicine (DICOM). DICOM is a standard format used in the medical field for sharing and viewing of medical images such as Computed Tomography Scan (CT SCANS), MRI and ultrasound The main goal of usage Computer Aided Design (CAD) software in medicine is manipulating medical imaging (DICOM). Image manipulation can be done with a geometric transformation (rotation, translations etc.)

and give out colours to produce a display that can provide more information for research purposes [23]. Medical images in CAD format can be converted into three-dimensional (3D) form.

If we consider that is basic strategy for development of methods and techniques for detection and quantitation of lesions in medical images has been based on the understanding of processes that would be involved in image readings by radiologists [20, 34]. The use of 3D images will help medical experts to diagnose the patient's condition more easily because the 3D images can be viewed in better and clearly than the two dimensional images (2D) [24], also image in 3D format can be rotated and changed.

This proves that it is possible for CAD software to be used in medical imaging technology. This is particularly useful for as medical images can be easily changed and animated for learning and research purposes [33].

Beside detection and manipulating imagine for example breast cancer, CAD software can use for planning of breast reconstructive surgery. CAD software has built-in tools for mass properties calculations such as volume, density, mass, surface area and center of mass which are simple to use. Preoperative breast volume estimation could significantly improve planning of breast reconstructive surgery following mastectomy including implant size determination in cases needing augmentation and assessment of how much should be excised in cases of breast reduction [36]. Idea is to create a 3D breast in software based on analyses have clinical benefit in planning reconstructive breast surgery. These methods can help the surgeon predict the esthetic effect of various breast surgeries and guide the choice of the most appropriate implant or/and flap preoperatively [37].

2.2 Stomatology

As already mentioned, many information and communication technologies have found application in the health sector, including the framework of modern dentistry. To achieve more efficient operations, reduce costs, increase user-patient satisfaction and ultimately profits many dentists in the world have their attention focused on the implementation of modern IT solutions to everyday practice. In dental medicine, CAD systems started to be used in the mid-1980s, when dental laboratories were used only due to the long duration of prosthetic work [35]. The first dentist who introduced CAD systems in stomatology in 1971 was doctor Duret. He developed dental CAD system for making dental crown using a virtual print [35]. In 1988, for the first time dentists in Germany have been start using CAD system in practice.

There are two categories of CAD systems in stomatology and divided into *chairside* (used in dental office) and CAD systems used in Dental – technical laboratory [9]. One of the use of the system is the formation of 3D tooth images and the right on the screen, the dentist can use the cursor to form a very refined, appropriate anatomical design of the toothache

that is missing. The resulting 3D models provide the ideal basis for designing compensation. In the designing of the in a very simple manner, and takes into account of the relation with the adjacent teeth, the teeth in the opposite jaw which establish appropriate contacts, but also on the relationship of compensation according to the soft tissue or the gums. Also, on the virtual model are marked and clearly recognizable critical zones that can be corrected with the offered tools [9].

Lately, more and more frequently CAD system in combination with CAM system (Computer Aided Manufacturing) are used in implantology.

3. CONCLUSION

Any progress in the field of information and communication technology simultaneously finds application in different spheres of medicine, as well as in dentistry. Expansion of information-communication technology in the future will contribute to an even more powerful impact on timely diagnosis, timely and adequate treatment, monitoring of the therapeutic effect, but also achieving high level of aesthetics in all branches of medicine and dentistry where it is necessary.

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